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PRELIMINARY INVESTIGATION OF EFFECTS OF GAMMA RADIATION ON
AGE-HARDENING RATE OF AN ALUMINUM-COPPER ALLOY

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AGE-HARDENING RATE OF AN ALUMINUM-COPPER ALLOY

By J. Howard Kittel

SUMMARY

A preliminary investigation was made to determine the effects of gamma radiation on the age-hardening rate of an aluminum-copper alloy at temperatures of 32° and 70° F. The gamma radiation from a 100-milligram radium source appeared to have no significant effect on the age-hardening rate of the alloy. A metallographic examination of the test specimens showed no microstructural changes that could be attributed to the gamma radiation.

INTRODUCTION

The fundamental research at the NACA Cleveland laboratory on the physical properties of materials includes a study of metastable-alloy states such as those that occur in the age-hardening alloy systems. The effects of heat on age-hardening alloy systems have been studied by other investigators (references 1 and 2). Very little research has been conducted, however, on the effects of energy in the form of electromagnetic radiation on metastable-alloy systems. In order to obtain more information on such effects, a preliminary investigation has been made at the Cleveland laboratory to determine the effects of electromagnetic radiation on an age-hardening alloy of aluminum and copper.

The energy associated with electromagnetic radiation becomes relatively high when wavelengths of the order encountered in gamma radiation are considered. Because of this factor and because naturally radioactive materials that emit gamma radiation are relatively easy to obtain, gamma radiation from a 100-milligram radium source was used.

Results from this preliminary investigation are presented in the form of curves showing changes in hardness as a function of aging time. Results are also presented from a metallographic study made on the test specimens to detect any changes in the microstructure that might have resulted from the gamma radiation.

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APPARATUS AND PROCEDURE

The commercial aluminum-copper alloy 24S was used for the age-hardening rate determinations. Eight specimens were used, each measuring 1 by 1/2 by 1/8 inch. Prior to aging, all specimens were simultaneously solution-treated at 920° F for 20 minutes in a bath of fused sodium nitrate. Immediately after removal from the salt bath the specimens were water-quenched. One set of four specimens was allowed to age at 70° ± 1° F for 75 hours and another set of four at 32° ± 1° F for 100 hours. Two of the specimens in each of the sets of four were continuously subjected to the gamma radiation from 100 milligrams of radium in equilibrium with its disintegration products in 10 sealed capsules. Each capsule contained approximately 10 milligrams of radium. The specimens were placed adjacent to the capsules in such a manner as to irradiate uniformly the specimens.

A commercial hardness tester with a 1/16-inch ball and 30-kilogram load was used to determine changes in specimen hardness during the aging process. The temperature of each specimen that was aged at 32° F was maintained at 70° F during hardness measurements.

RESULTS AND DISCUSSION

Average change in specimen hardness is plotted against aging time in figure 1. Each experimental point on the curves represents the average of 10 hardness readings, five of which were made on each of two specimens. The maximum observed difference between the hardness change of the irradiated specimens and the hardness change of the nonirradiated specimens occurred at 6 hours in the aging experiments at 32° F. At this aging time the observed difference in hardness change was 1.6 Rockwell 30-T hardness units. This difference in hardness change, however, is believed to have no significance because of the fact that hardness readings on individual specimens were found to vary by as much as ±1.5 hardness units. A variation in hardness reading of 1.5 Rockwell 30-T units is not abnormal for this type of material. Under the conditions used in these age-hardening rate determinations, it appears that gamma radiation had no significant effect on the age-hardening rate of the aluminum-copper alloy 24S.

From absorption data in references 3 and 4, calculations were made of the gamma radiation absorbed by the irradiated specimens and converted into heat. The calculations showed that under the conditions of this investigation each specimen would absorb about 0.001 calorie per hour. This rate of heating would induce a negligible temperature increase in the specimens.

The metallographic examinations of the test specimens showed no changes in the microstructure that could be attributed to the gamma radiation.

SUMMARY OF RESULTS

The following results were noted in determinations of the age-hardening rates of the aluminum-copper alloy 24S with and without gamma radiation:

1. Gamma radiation from a 100-milligram radium source appeared to have no significant effect on the age-hardening rate of the alloy specimens.

2. No metallographic changes were noted in the alloy specimens that could be attributed to the gamma radiation.

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National Advisory Committee for Aeronautics,
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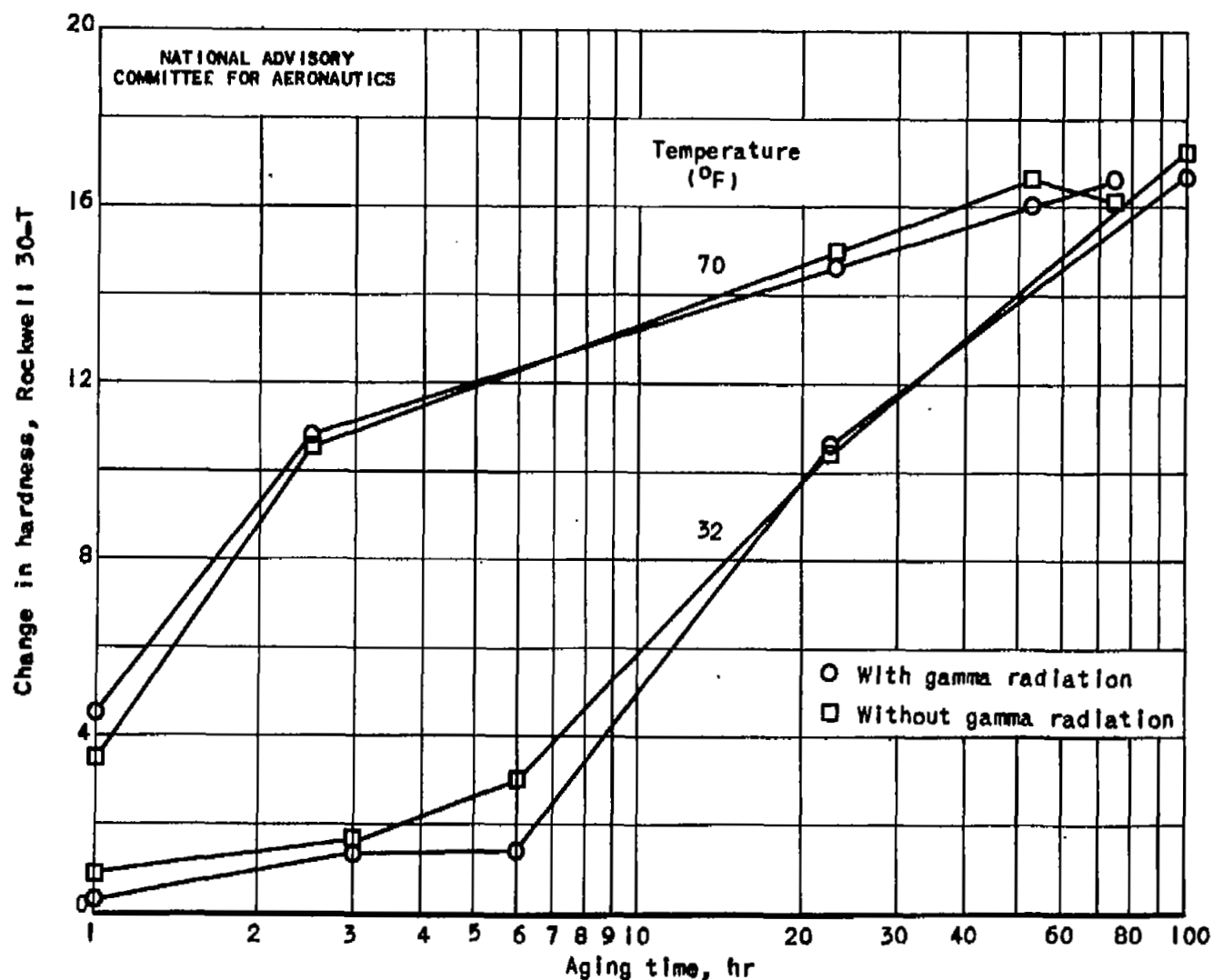


Figure 1. - Total average change in hardness of aluminum-copper alloy 24S in aging experiments with and without gamma radiation. Each experimental point represents the average of 10 hardness readings.

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